

Crystal Creation Lab

Purpose: To create Alum and Epsom Salt Crystals.

Background Information:

Please read the following background information on Alum Crystal Formation. Please highlight key points and write a 5-10 word summary next to each paragraph.

Many substances will dissolve in water forming aqueous solutions. The mass of a substance, also termed the solute, that will dissolve in a given quantity of water, usually set at 100 grams, is not unlimited. A solution that contains the maximum amount a substance as will dissolve a given amount of water is called saturated. The mass of substance present in a saturated solution prepared with 100 g of water is known as the solubility of the substance. The solubilities of many substances are compiled in handbooks of chemistry. For instance, the solubility of sodium chloride is 35.6 grams NaCl in 100 g of water at 20°C. The solubility changes with temperature. Most substances are more soluble at higher temperatures than at lower temperatures. When a solution saturated at a higher temperature is cooled to a lower temperature, one of two things occur. Some of the excess solid will crystallize out of the solution, forming crystals on the bottom of the container, or, all the solid may remain in the solution. The cool solution, where everything remains dissolved, will be supersaturated, that is, it contains more solute than allowed by its solubility at that temperature. Supersaturated solutions are unstable and will, in most cases, deposit the excess solute in crystalline form when disturbed. An example of this are chemical hot packs, available in many pharmacies, which look like plastic packets of liquid with a small metal disk in them. When the metal disk is "clicked", it sends vibrations through the liquid, a supersaturated solution of sodium acetate, causing the excess solute to crystallize, giving off heat. The hot pack is regenerated by boiling it in water for 15 to 30 minutes.

Another way to force a solute to crystallize is by evaporation of the solvent. When a saturated aqueous solution of a substance is allowed to stand in an open container at room temperature, the water will slowly evaporate forcing the solute in excess of the solubility to crystallize.

In an aqueous solution of $\text{AlK}(\text{SO}_4)_2$ the Al^{3+} , K^+ , and SO_4^{2-} are surrounded by molecules of water (they are hydrated). These ions do not have an orderly arrangement in solution. When the compound is forced to crystallize, the ions must begin to join each other in their characteristic order. This process of nucleation may occur spontaneously when the ions of alum collide with appropriate orientation and with sufficiently low kinetic energy to permit them to "stick" to each other and prevent them from rebounding. Occasionally, some "foreign" solids (irregularities on the wall of the container, dust particles) will serve as nuclei (or starting points) for the formation of crystals. Once a tiny crystal has formed, ions in their random motion through the solution will hit the faces of the crystal, join the orderly array of ions, and make the crystal grow. To keep the crystal growing, the solution must be cooled to even lower temperatures or solvent must be evaporated continuously. To obtain large crystals, small seed crystals are first prepared. A well-formed seed crystal is then suspended in a saturated growing solution and the solvent slowly evaporated. By replenishing the growing solution a huge, perfectly octahedral crystal of alum can be obtained.

Excerpt from **Growing Alum Crystals** by David A. Katz
<https://www.raci.org.au/document/item/249>

Crystal Creation Lab**Prelab Questions:**

1. Using the Background Information text define:
 - a. Solute
 - b. Saturated Solution
 - c. Solubility
 - d. Supersaturated Solution
2. *When a solution saturated at a _____ temperature is cooled to a _____ temperature, one of two things occurs. What are these two things?*
3. The three ions in the compound $\text{AlK}(\text{SO}_4)_2$ are listed below. Determine if the ion is a cation or anion, what its charge is, and how many electrons did it have to gain or lose to get that charge.

Ion	Cation/Anion	Charge	# Electrons Gain/Lost
Al^{3+}			
K^+			
SO_4^{2-}			X
4. The formula for the compound is $\text{AlK}(\text{SO}_4)_2$. The two means that there are two units of SO_4^{2-} . Why do you think two are needed?

Crystal Creation Lab

Experiment

Hypothesis: Write a hypothesis stating which chemical (Epsom Salt or Alum) will have higher percent yield of crystals. A complete sentence is required. Do not use an if/then state.

Materials:

- Ring Stand
- Ring Clamp
- Wire Gauze
- Gas Hose
- Bunsen Burner
- Beaker Tongs
- Bottle of Distilled Water
- 10 mL Graduated Cylinder
- 50 mL Beaker
- Glass Stir Rod
- 2 Toothpicks
- Approximately 6 inches of String
- 2 Film Canisters
- Scissors

Procedure:

Day 1

1. Gather materials.
2. Construct solution heating setup using: ring stand, ring clamp, wire gauze, Bunsen burner and gas hose.
3. Tie one end of the six inch string to one of the toothpicks. Place the toothpick on the top of a film canister and trim the string so that it barely touches the bottom of the canister.
4. Repeat Step 3 with the rest of the string and the second toothpick.
5. Label the two film canisters, one Alum and one E.Salt. Both should have someone's initials from your group and the class period.
6. Weigh out approximately 5 g of aluminum potassium sulfate, $\text{AlK}(\text{SO}_4)_2$, also known as Alum. Record this weight below. Pour the Alum into the 50 mL beaker.
7. Measure out 5 mL of distilled water using the graduated cylinder and add it to the 50 mL beaker with the Alum.
8. Stir mixture with glass stir rod.
9. Place 50 mL beaker with Alum mixture on top of wire gauze on the ring stand.
10. Light Bunsen burner and adjust the burner until it has a small flame. Slide Bunsen burner under the wire gauze.
11. Carefully stir mixture with the glass stirring rod until the mixture is dissolved. **DO NOT PUT YOUR FACE OVER THE BEAKER.** Do not boil the liquid.
12. Turn off the gas and using the beaker tongs remove the 50 mL beaker. Set aside to cool.
13. After a few minutes (once the glass is cool) pour the solution into the film container marked Alum. Place toothpick on top with string hanging into the solution.
14. Repeat steps 6 – 13 with Epsom Salt. **EXCEPT on step 6 use 7 g of Epsom Salt and in step 7 use 5 mL of water.**
15. Place your two film canisters on the tray set out for overnight storage.
16. Wash all of your dishes and return to where you found them. Make sure your area is clean like you found it.

Crystal Creation Lab**Procedure****Day 2**

1. Obtain your crystals.
2. Remove your crystals from the film containers, weigh, and record your data.
3. Choose your best Alum and E.Salt Crystals. Take a picture of both crystals and paste into the lab report below. Place both crystals in their appropriate spot in the front of the room for judging.
4. Place left over Alum Crystals in waste container labeled Alum Crystals.
5. Throw Epsom Salt Crystals away in the trash.
6. Clean/wash all equipment and return to the center lab bench.

Crystal Creation Lab**Data**

Starting Amount of Alum _____ g

Starting Amount of Epsom Salt _____ g

Weight of Alum Crystals _____ g

Weight of Epsom Salt Crystals _____ g

Data Analysis

Picture of Alum Crystal

Picture of Epsom Salt Crystal

1. Percent Recovery of Alum

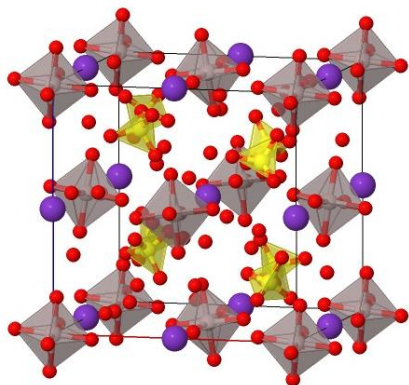
$$\frac{\text{Weight of Alum Crystals}}{\text{Starting Amount of Alum}} \times 100 \% = \underline{\hspace{2cm}} \times 100 \% =$$

2. Percent Recovery of Epsom Salt

$$\frac{\text{Weight of Epsom Crystals}}{\text{Starting Amount of E. Salt}} \times 100 \% = \underline{\hspace{2cm}} \times 100 \% =$$

Crystal Creation Lab**Data Analysis**

3. Which type of compound produced better crystals? Why do you think this?
4. This is the crystal structure of the Alum crystals you created. Using what you know about ions label the following atoms. (Hint: You've listed three of the ions in Prelab #3.)



Purple _____

Yellow _____

Gray _____

Red _____

<http://crystals.otterbein.edu/gallery/index.html>